ENGINEERING CASE LIBRARY

ECL 178A

NEGLIGENCE (A)

A case study concerning a products liability lawsuit which arose out of an industrial accident in which Plaintiff was severely injured while operating a large mechanical press. Emphasis is on engineering aspects of the case, as extracted from depositions of expert witnesses. Important elements of Plaintiff's trial brief, legal arguments, etc. are also presented.

Names, places, and locations have been disguised. The initial contact and subsequent conversations between Messrs. Freeman and Thomas have been fictionalized.

 Prepared by Drew V. Nelson with the support of the National Science Foundation. The cooperation and assistance of Messrs. Richard Goodman and James Tuck and Profs. H. O. Fuchs and G. Kardos is gratefully acknowledged.

NEGLIGENCE

George Thomas sat at his desk, relaxing with a cup of coffee and the latest edition of The Engineering Gazette. The phone rang, and he reached quickly to his right for the receiver.

"Hello, Thomas speaking."

"Good morning, Mr. Thomas, this is Bill Freeman from the law firm of Freeman, Townsend, and Hawkins in Chicago."

"Yes, sir," said Mr. Thomas, "what can I do for you?"

"Well," replied Mr. Freeman, "I understand you're in the business of investigating industrial accidents and mechanical failures. You were referred to me by the Northeast Research Institute."

"That's right," said Mr. Thomas, "I've been in that line of work for about seven years now - - ever since I left N.R.I."

Mr. Thomas was an independent consulting engineer, specializing in custom machine design, stress analysis, and control systems. In recent years, he had conducted industrial accident investigations for several attorneys, insurance companies, and manufacturers.

Mr. Freeman continued, "I need an expert technical opinion about the cause of an accident involving a power press. You see, the fellow I'm representing had both arms amputated when the press he was running malfunctioned."

"That's awful," muttered Mr. Thomas. "How did it happen?"

"Well, my client, Earl Williams," explained Mr. Freeman, "was reaching into a press to remove a part that had just been stamped . . . this was his regular job . . . when the press suddenly repeated a stroke. The ram came down on his arms and jammed to a stop, pinning him right there. He never had a chance."

"I see," said Mr. Thomas, "Then I guess you're gonna sue his employer and . . ."

"That's right," said Mr. Freeman. "I think we'll have a good case against them too. By the way, Mr. Thomas, do you know much about press operations?"

"Oh, sure," answered Mr. Thomas, "matter of fact, I even designed a small press."

Mr. Thomas had designed a machine for blanking paper stock, embossing, etc. for the Happy Greeting Cards Company. He was also familiar with large press operation from the years that he had worked for the Dearborn Motor Car Company and the Azusa Aircraft Company.

Mr. Freeman continued, "Now, the people at N. R. I. told me that you were very qualified in the area of pneumatic control systems."

"Well, I'm glad to hear that," said Mr. Thomas. "I have had a good deal of experience in that field. While I worked at N. R. I., I designed a special valve and actuator for Colossal Enterprises."

"Yes, N. R. I. mentioned that too," said Mr. Freeman. "That's one of the reasons I called. You see, we're pretty sure the air control valve failed on the press my client was operating and caused the malfunction."

"That could do it all right," remarked Mr. Thomas.

"Well, now, Mr. Thomas, from what little I've told you, do you think you might be interested in doing some work on this case in the next few months," asked Mr. Freeman.

Mr. Thomas paused for a few seconds and replied, "At this point, I think I would. Let's see, I should have the time available too."

"Good. Of course I'd like to fill you in on some more details of the case before you decide," emphasized Mr. Freeman.

Mr. Freeman was scheduled to fly to Arizona the following week on other business and arranged to stop on the way in Wichita, Kansas, about ten miles from Mr. Thomas' home.

Mr. Freeman and Mr. Thomas met for lunch the following Tuesday at the Wichita airport. Mr. Freeman explained his interest in the case: "I've decided to specialize in product liability cases. I've written a few articles on the subject, and I'm currently trying to prepare a lawyer's textbook on design liability - if I can ever find the time." Mr. Thomas inquired, "By the way, how did you come to represent Earl Williams?" Mr. Freeman replied, "Well, Earl's family first sought the services of a local attorney down in Alabama. Apparently, this attorney had read one of my articles and,

on that basis, recommended me to the Williamses. A few weeks later, we filed suit in Federal Court in Illinois. I want to see that Earl gets properly compensated - - if that's ever possible - - for what happened. His case makes you wonder just how many others are in similar danger." Mr. Thomas nodded his agreement.

In ensuing conversation, Mr. Thomas described various products he had designed, some of the investigations he had conducted, and his educational background: "I graduated from the University of Kansas with a Bachelor's degree in Civil Engineering. That was in 1943. My first employer was Azusa Aircraft Co., and that, naturally, was because of the war. I took some graduate courses in metallurgy and aircraft structural analysis." Mr. Freeman, in turn, gave further details of the accident and described the defendants and the relationship of each to the case. He paused and then said, "Well, I'm certain you're qualified to investigate this case, and I'd like to have you work for me. How about it?" Mr. Thomas quickly replied, "I'd be glad to. Where do we start?"

Mr. Freeman then gave Mr. Thomas copies of the depositions* of the Plant Supervisor, the Press Maintenance Engineer, and Earl Williams, along with drawings, blueprints and photographs of the subject press and its control system. "I'd like you to review this material," said Mr. Freeman. It'll give you a pretty good idea of where we stand at this point. After you do that, please get in touch with me, and we can discuss steps to be taken in the investigation."

The essence of what Mr. Thomas learned by reading the deposition and reviewing the press specifications is presented in the following pages.

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*A deposition is the oral examination of a witness prior to a court trial. Questions are asked by attorneys for the defendant(s) and plaintiff(s) in the presence of a court reporter. The court reporter swears the witness and makes a shorthand record of the examination (which is later transcribed into typewritten form and becomes a part of the permanent court record). A deposition discloses information pertinent to the case and may help to pinpoint issues and minimize misunderstandings. This is particularly useful in cases of a complex technical nature. In addition, a deposition often helps attorneys to evaluate the strength of their arguments and those of their opposition. An attorney may have experts with him during a deposition to suggest questions for him to ask, but such experts cannot ask questions themselves. A deposition is always taken in accordance with specified rules (e.g., Rule 26 of the Federal Rules of Civil Procedure).

THE DEFENDANTS

Associated Tool & Die Company

A. T. & D. Co. of Cincinnati, Ohio is a major U. S. manufacturer of power lawn mowers, toy wagons, tractor mowers, and similar products (since 1935). They are the parent company of Associated Products, whose Birmingham, Alabama plant opened in 1960.

National Power Press Company

National Power Press of South Bend, Indiana, is a major U. S. power press builder. In 1949, they built the press involved in this case.

Western Aerospace

Western Aerospace, formerly of Houston, Texas (now merged with International Systems in San Diego) bought the National press for $35,000 in 1949. They used it on a sporadic basis from 1950 to 1959 for low production aircraft work and sold it to A. T. & D. Co. for $25,000 in 1960. The press was installed at Associated Product's Birmingham plant the same year.

Precision Valve Company

Precision Valve of Flint, Michigan produced the air control valve for the press involved in this case. Their valves were standard on all National presses from 1948 to 1958.

United Spring Company

United Spring of Bridgeport, Connecticut supplied the spring used in the pilot section of the Precision Valve.

COUNSEL

William Freeman, for the Plaintiff, Earl Williams

James Simpson, for the Defendant National Power Press Company

Robert Schultz, for the Defendant Precision Valve Campany

Richard Cunningham, for the Defendant United Spring Company

Vincent Garibaldi, for the Defendant Western Aerospace

Thomas O'Brien, for the Defendant A. T. & D. Company

Twenty-one year old Earl Williams earned $1.40 an hour working the second shift (6:00 pm to 3:30 am) as a press operator in the Associated Products Company's plant in Birmingham, Alabama.

On the night of 12 March 1964, co-worker Charlie Hancock and he were assigned the job of stamping lawn mower decks using the 400 ton National press. This press is shown in Exhibit 1 and described in the Appendix. To do this job, both men would stand on opposite sides of the press. First, Charlie would put a 20 lb. steel blank into the press. Then both men would push palm buttons to actuate a single stroke of the press. Immediately, a powerful ram (carrying a punch) would descend, form a deck, return to the top and stop automatically. Earl would then reach into the press and remove the deck. Hour after hour they repeated this cycle.

At about 10:15 pm, Earl reached into the press to remove another deck as Charlie turned to pick up another blank. Suddenly and without warning, the press began another stroke. The ram came crashing down on Earl's outstretched arms and jammed to a stop as it hit bottom stroke. Several minutes passed before anyone tried to extricate Earl. Finally, Charlie and foreman Tommy Joe Edwards stopped the main press motor, reversed it, and "inched" (see Appendix) the ram off his arms. They rushed him, still conscious, to a nearby hospital. Earl lost both arms below the elbow.

In his deposition, Earl Williams disclosed that he had received only "five to fifteen" minutes of on-the-job instruction in press operation. He further testified that he had never been aware of the hazards involved in his job: "I didn't know there was any danger, no. I knew you could get cut or something if you wasn't careful."

Arthur Hayes, Plant Supervisor and Chief Product Engineer in Birmingham, was about to retire for the night when he received a phone call informing him of the accident. He rushed to the plant and sent most of the second shift home. As he walked over to the press, he tried to visualize what could have caused the press to malfunction so catastrophically. His first reaction was that somehow all the springs on the brake had failed simultaneously, but Mr. Hayes dismissed this thought when he made a quick inspection of the clutch-brake unit and found it to be in apparently good working order.

Mr. Hayes then asked a die setter to start the main press motor. Immediately, the ram began to cycle up and down and continued to do so even when Mr. Hayes pressed the emergency stop button. The repeating press could only be halted by

cutting off the main motor. Tired and puzzled, Mr. Hayes returned home.

Mr. Hayes arrived at work early the next morning and immediately met with Mr. Herman Meister, Press Maintenance Supervisor. Mr. Meister had been in charge of press maintenance for A. T. & D. Co. in Cincinnati from 1945 to 1960. The management of A. T. & D. Co. considered him to be "the best press man in the country" and had persuaded him to come out of retirement to supervise maintenance at Birmingham. In fact, it was he who had inspected and approved the National press for purchase by A. T. & D. Co. from Western Aerospace.

Hayes and Meister began a thorough inspection of the press. First they checked the clutch-brake unit and pneumatic lines and found them to be in good condition. Next they assisted the plant electrician in checking the entire press electrical system. Again, they could find nothing wrong. Finally, they turned their attention to the Precision air control valve. This valve is shown in Exhibit 4 and described in the Appendix. What occurred next is revealed by Mr. Meister's account given in deposition:

Q: (by Mr. Freeman): Did you have occasion to check out the air system of the press?

A: After we had checked the electricity, I took the valve off and I checked my valve.

Q: Which valve are we talking about?

A: The air valve. That's what I call it, the Precision. I took it off and put it on my bench and put a piece of wrapping paper around it to see what was wrong with it.

Q: Then what did you do?

A: Then I took the cover off, and you can see nothing there, and I took this cover off, and there is a little screw in there, then there is this ball and a spring and another ball, and then this pin there, and that solenoid controls that. I took the little screw off - - .

Q: And after you took the screw off, what did you take out next?

A: There is a little ball in there, and I found a little fragment of spring in there - - .

Q: Now, after you took these parts out of the valve, did you go any further in your investigation, or did you stop there?

A: No, I stopped there. I just took that in the office and put it on the manager's desk.

The broken spring and fragment found in the Precision Valve are shown in Exhibits 5 and 6. After completing his investigation, Mr. Meister replaced the Precision Valve with two Ajax air control valves (which greatly decrease the probability of such a catastrophic press failure). The press, which had been repeating prior to the removal of the Precision Valve, operated in a completely normal manner again.

Under further questioning, Mr. Meister disclosed his familiarity with a recurring spring problem in the Precision Valve. In fact, it was a problem he had known about as far back as 1946 when he worked in Cincinnati.

Q. (by Mr. Freeman): Had you ever opened up a pilot chamber, a pilot valve on one of these Precision Valves before?

A: Well, I seen the same thing happen in Cincinnati, what happened to this one, the spring breaking.

Q: And what happened at that particular time? How was this brought to your attention, that there was a problem?

A: Well, the press went over and then stopped on the bottom. Then the operator came and told me something is wrong with the press, and I went and checked it. I got the electrician and checked the electrical parts, nothing wrong with it, and I took the valve out . . .

. . . . . .

Q: And you took a Precision Valve off that?

A: And put another one on, a repaired one.

Q: Did you tear down the one you took?

A: Yes, most of the time I found one of those things broken.

Q: You are referring to the spring?

A: That's right.

Mr. Meister recalled further that the broken spring which he had found in Cincinnati in 1946 had failed in almost an identical manner to the spring which he had discovered in Birmingham 18 years later. The questioning continued.

Q. (by Mr. Schultz): Referring to that 1946 situation in Cincinnati, did that ever happen again, or was that the only time it happened, in 1946?

A: I replaced more than one of them. I used to carry them springs in stock. They used to send them in to me . . .

Q: Where did you get those springs?

A: From Amerco* in Toledo, Ohio.

Q: You got them from Amerco, but you didn't get them from Precision Valve?

A: No.

Q: You say this happened more than one time where the spring went bad on one of them?

A: That's right.

Q: Would you notify your superiors of that?

A: Well, he would trust me enough to keep the place going. I didn't want to go up to him with every little trouble on the presses. I just ordered new parts and replaced them.

Q: Did you ever tell anybody from Amerco that the spring had broken?

A: No.

Q: Did you ever tell anybody from Precision Valve Company that that had happened?

A: No. The only one I knew from Amerco was Langfried. I think he is retired now. That is the only man I knew over there. But I never told him anything about breaking springs, because he was chief engineer over there. He wasn't interested in valves.

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*Amerco is the trade name for the American Tool and Machine Company which, along with National, were the principal press builders using Precision Valves. A. T. & D. Company had a number of Amerco presses in their Cincinnati plant.

Q: Is there anybody you can tell me of at Associated Tool and Die or Associated Products that knew about these springs breaking before Mr. Williams had his accident?

A: I don't think so.

Q: You are the only one that had that knowledge, right?

A: Because I followed the press line a good number of years. I used to build them.

The line of questioning turned briefly to Mr. Meister's inspection and approval for purchase of the National press.

Q: (by Mr. Schultz): Did you ever check with Western Aerospace for their maintenance records on this machine?

A: I had the maintenance records, but there was nothing on it that they ever done anything on it.

Q: Did you check to see how many hours this press had been used?

A: I couldn't tell you, no.

Q: Did you know the year of manufacture when you bought the press?

A: No, I didn't check.

Near the end of his deposition, Mr. Meister revealed some of his viewpoints concerning the press maintenance trade.

Q. (by Mr. Simpson): Down in Alabama when you were down there, did you ever take any of these machines apart during the six years you were down there to see if there was any wear and tear on any of them?

A: No, it was not necessary to take them apart if they were running good.

Q: What did you do, wait until they malfunctioned and then decided to check it?

A: Nobody would think things like that would happen.

Q: You know things like this don't wear forever.

A: That's right, but you don't take a machine apart when you buy it to see how it's made.

Q: Did you ever take one of those valves apart?

A: Yes, when it went bad.

Q: You waited until it went bad before you took it apart?

A: This is the only thing you can do.

Q: You say that is the only thing you can do?

A: When can you do it? You can't take machines apart when they are running.

Q: Do I understand that down at this plant you never took any machine apart, or never took any parts of it apart to see that it might be wearing out?

A: You couldn't see it wearing out. If anything was going wrong, you generally look at it and fix it. But if you can't see nothing go wrong, you can't tear machines apart.

Q: When you were in charge of maintenance in Cincinnati, or down in Birmingham, did you keep any records on what work you did on each machine, sir?

A: No, I never did. I kept it all up here (pointing to his head).

Q: To your knowledge, did anybody at A. T. & D. or Associated Products keep any records as to what you did on each machine?

A: I don't know. I don't think so.

APPENDIX

MECHANICAL PRESS

A mechanical press taps kinetic energy stored in a spinning flywheel to provide the bulk of the work required by a reciprocating ram in its stamping stroke. An electric motor also contributes energy to the ram during the stroke, but its main duty is to restore energy expended by the flywheel. Most mechanical presses transfer energy from the flywheel (and motor) to the ram through a pneumatic, friction clutch-brake unit, a gear train, and crank(s) or eccentric gear drive(s). A wide variety of gearing and cranking arrangements are used depending on particular press applications.

The National press involved in this case is a 400 ton capacity, straight-side, twin-driven, double-geared, single-action, double-crank press. See Exhibits 1 and 2.

The tonnage capacity specifies the thrust exerted on the ram at a point just above bottom stroke (usually 1/4" to 1/2", depending on individual manufacturer's specifications). The crank method of converting rotary motion to straight thrust provides a varying mechanical advantage between drive and ram. At approximately midstroke, the advantage is zero. Near bottom stroke, a toggle effect occurs, and the mechanical advantages increase tremendously. This characteristic of mechanical presses is desirable for most stamping operations, particularly deep draws.

Most smaller presses have single-driven crankshafts. The torsional deflection of the crankshaft becomes objectionable in larger presses (with longer crankshafts), for it causes a slight tilting and uneven loading of the ram on double crank presses. Twin drives are thus used on most large crank presses to minimize such difficulties.

Presses of slower speed (usually less than 20-25 strokes/minute) typically are double geared to provide necessary speed reductions. This is frequently true of presses used for longer stroke draw operations.

Depending on speed and capacity requirements, mechanical presses are available with non-geared or single-, double-, and even quadrupled-geared drives.

An important feature of most mechanical presses are pneumatic, counter-balancing cylinders, which offset the weight

of the ram and punch. Air cylinder counter-balance minimizes the play of press drive members so that the punch will contact the work solidly.

CLUTCH-BRAKE UNIT

The heart of any mechanical press is the clutch-brake unit. The National press involved in this case has a mechanically interconnected friction clutch-brake unit, pneumatically actuated. See Exhibits 1, 2, and 3.

The entire clutch-brake unit is keyed to a driveshaft. When the clutch is disengaged, powerful brake springs clamp brake discs against stationary brake plates. The brake plates are connected to the press frame in a manner which permits their axial movement but prevents their rotation.

To engage the clutch, pressurized air is admitted to an operating cylinder through a passage in the drive shaft. The air moves a clutch piston, which is connected to a brake pressure plate by studs, and thereby compresses the brake springs. This action, in turn, releases the pressure of the brake plates on the brake discs and establishes clearance between the plates and discs. As the piston continues to move outward, the driving discs clamp against the clutch discs. The driving discs are mounted on the flywheel, which rotates freely on the drive shaft, and when the clutch is so engaged, flywheel energy is transmitted to the drive shaft.

To disengage the clutch, air pressure in the operating cylinder is exhausted, and the brake springs retract the piston, first disengaging the clutch and then applying the brake.

Since a single piston mechanism operates both clutch and brake, overlap is avoided; when the clutch is engaged, the brake is disengaged, and vice versa.

AIR CONTROL VALVE

The Precision Valve is a pilot-operated, solenoid valve and is depicted in cross section in Exhibit 4a. As used on the Verson press, this valve controls the delivery of air to the clutch-brake and thereby controls the motion of the ram. The main spool shifts back and forth (total travel of about 1/8") and directs line pressure air either to the clutch (ram moves) or to exhaust (ram stops and remains stationary). The spool moves in response to air flow controlled by the

pilot section, which consists of a solenoid and two balls resting on the ends of a spring. When the valve is de-energized, the left hand side of the valve is under pressure, and the spool is forced to its extreme right-hand position. The lip (See point (A) in Exhibit 4a) prevents line pressure from reaching the clutch piston. When cycling of the ram is desired, an electrical impulse (initiated by the operators pressing the palm buttons) energizes the solenoid coil, causing the solenoid armature to move outward about 0.11 in. The armature, in turn, pushes an adjacent .250 DIA. ball off seat, compresses the spring, and forces the other ball to block the orifice shown in Exhibit 4a at point (B). Pressurized air (previously contained on the left-hand side of the spool chamber) quickly escapes around the unseated ball and through the pilot exhaust port. The change in pressure distribution in the spool chamber forces the spool to the left. Line pressure air is then admitted to the clutch piston while the lip (see point (C) in Exhibit 4a) blocks the main air exhaust.

After the ram has completed its stroke (taking 3-4 seconds), a rotary cam limit switch automatically breaks the current to the solenoid, the armature is retracted, and the balls reseat. Pressure is immediately restored to the left side of the spool chamber, causing the spool to shift to the right, which, in turn, cuts off line pressure air to the clutch piston and opens it to exhaust. The clutch disengages immediately and the reciprocal spring loaded brake is automatically applied, stopping the ram.

SPRING

The spring used in the Precision Valve pilot section is shown in Exhibits 5 and 7. The particular spring found in the allegedly malfunctioning Precision Valve was stainless steel, unground (but squared), and had chamfered coil ends (to overcome a problem of the ends digging into the walls of the bore in which the spring is contained).

INCHING

Inching is a special press function in which the ram moves in small, successive increments. This is accomplished by brief clutch engagements controlled automatically through the air control valve by an electrical relay. "Inching" is useful for die setting and tryout.

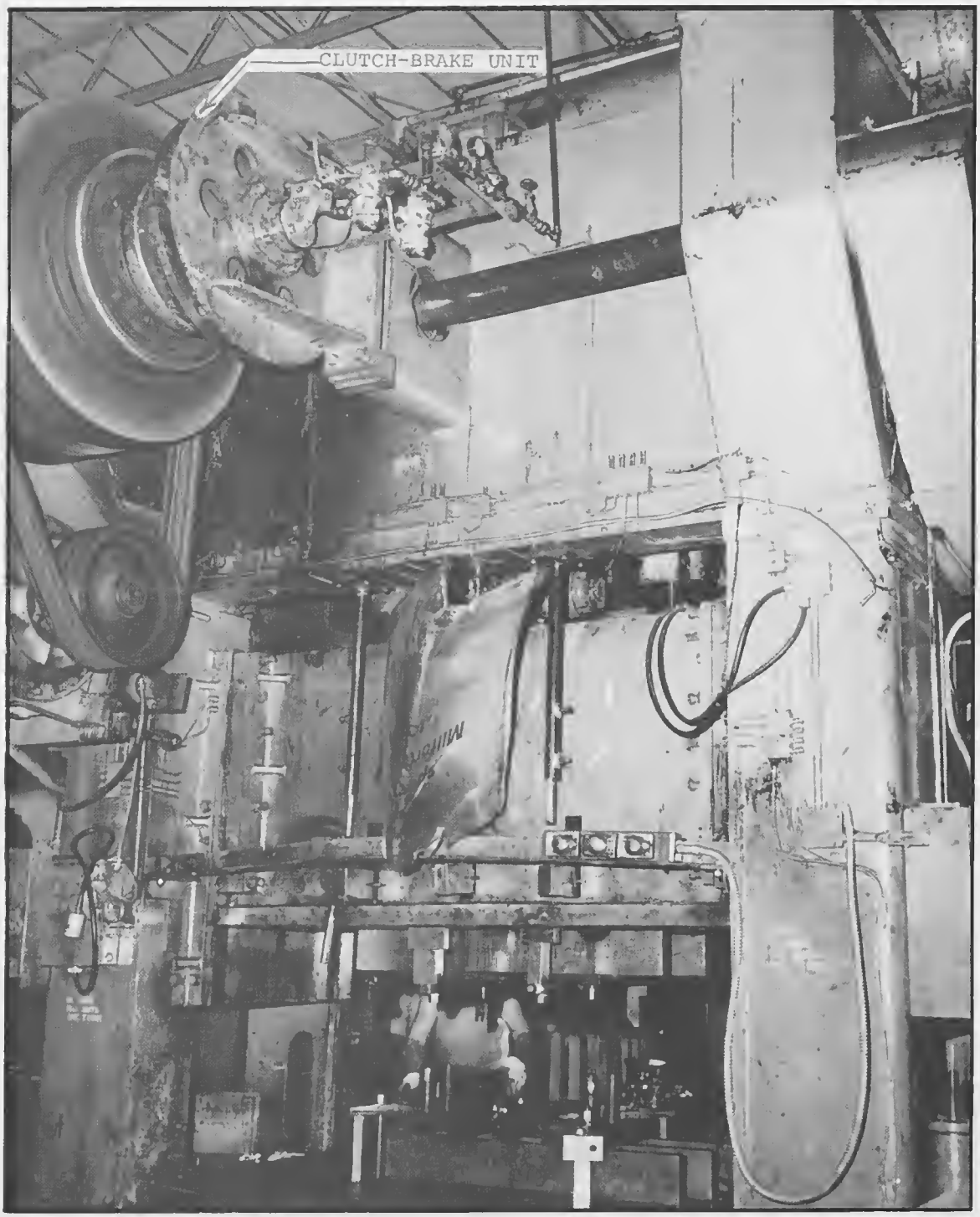


EXHIBIT 1

"NATIONAL" 400 TON MECHANICAL PRESS

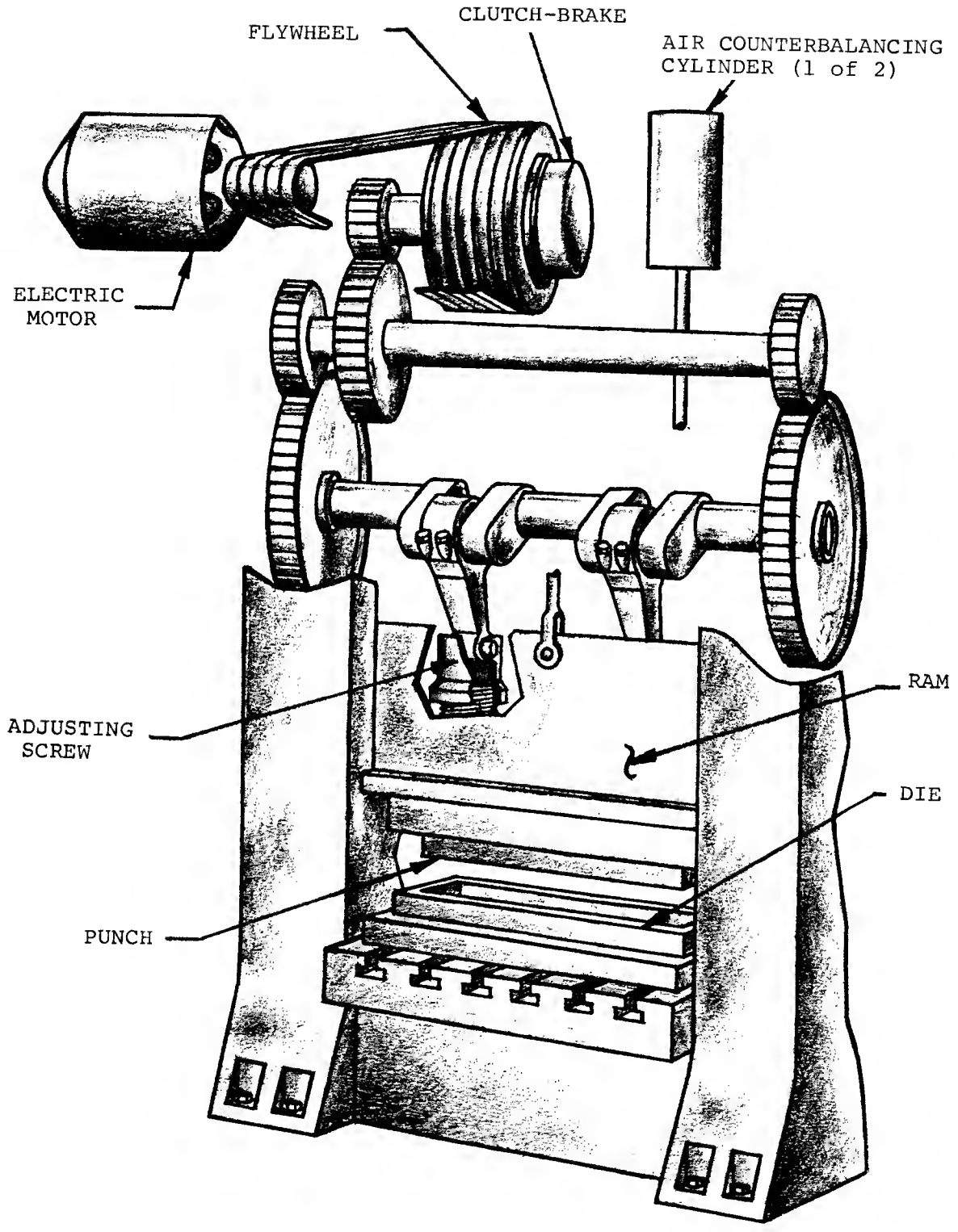


EXHIBIT 2

ELEMENTS OF A DOUBLE-GEARED, TWIN-DRIVE, DOUBLE CRANK, STRAIGHT-SIDE MECHANICAL PRESS

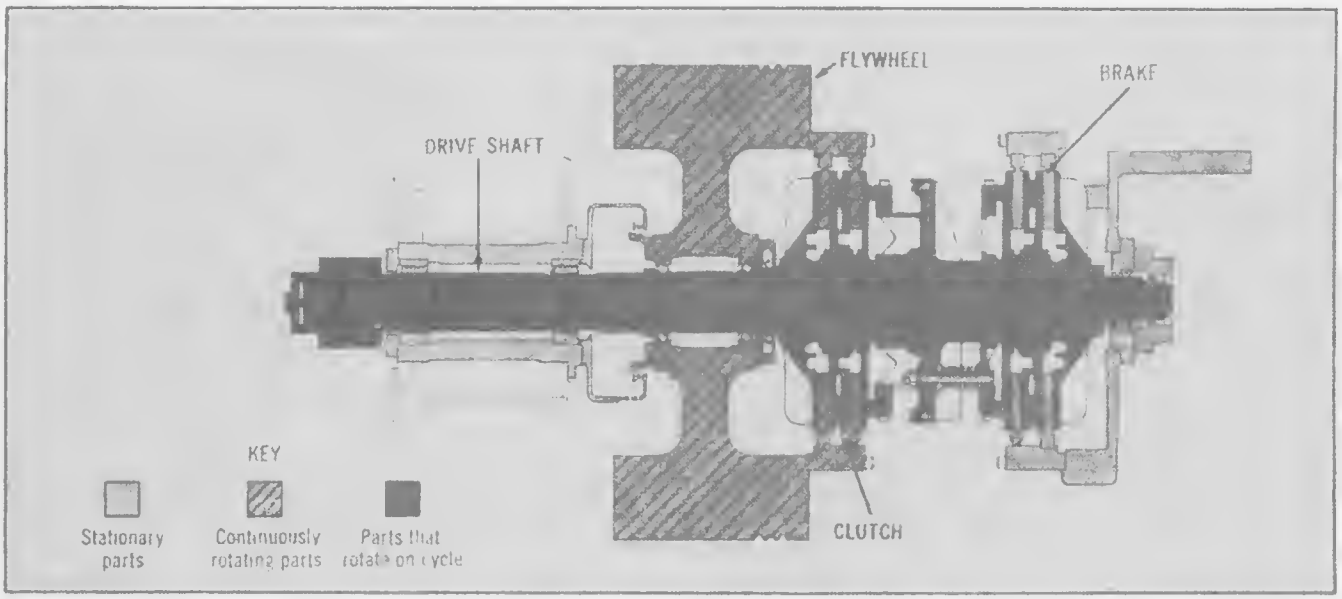


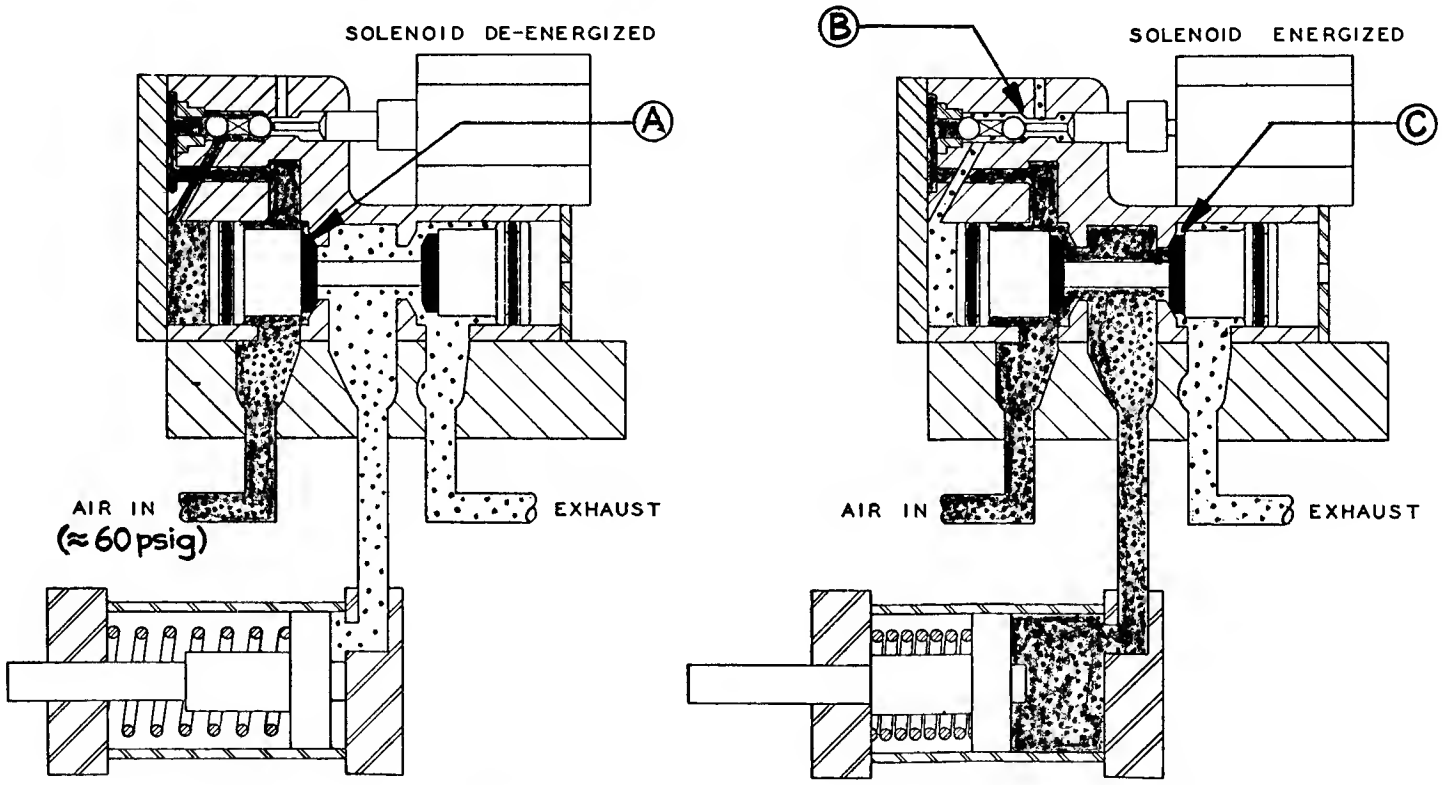
EXHIBIT 3

CLUTCH-BRAKE UNIT

SCHEMATIC DIAGRAM SHOWING PRINCIPLE OF OPERATION

MODEL # 300 – THREE WAY AIR VALVE

PAT. PENDING



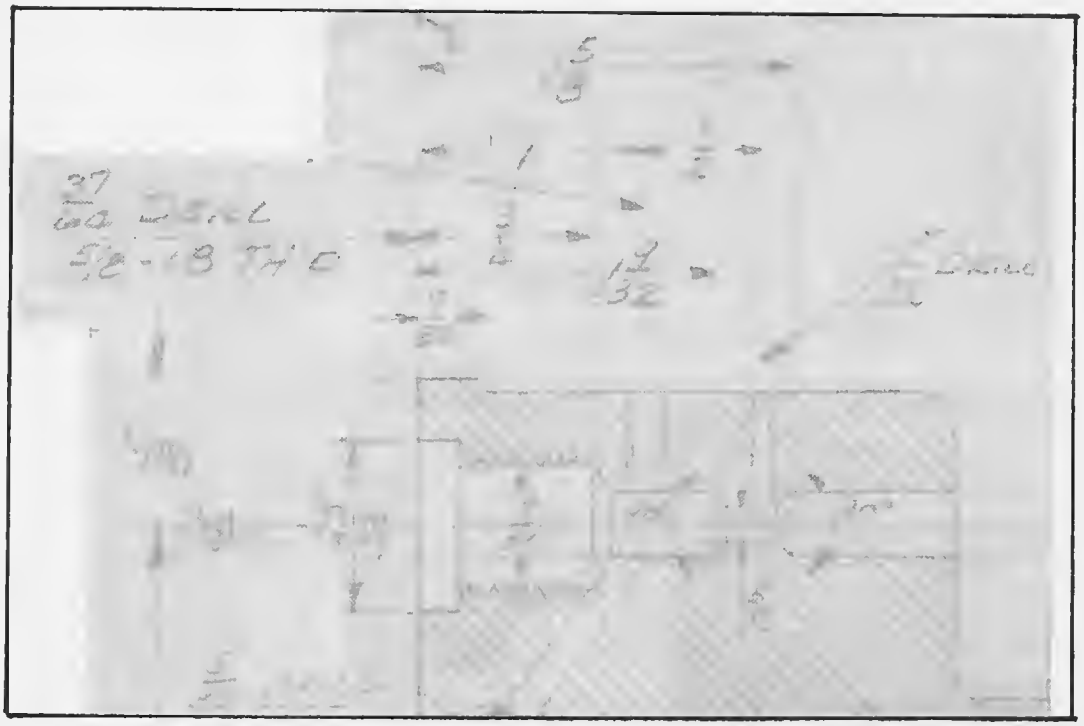
= LINE PRESSURE

= EXHAUST AIR

EXHIBIT 4a

"PRECISION" VALVE OPERATION SCHEMATIC

ECL 178A



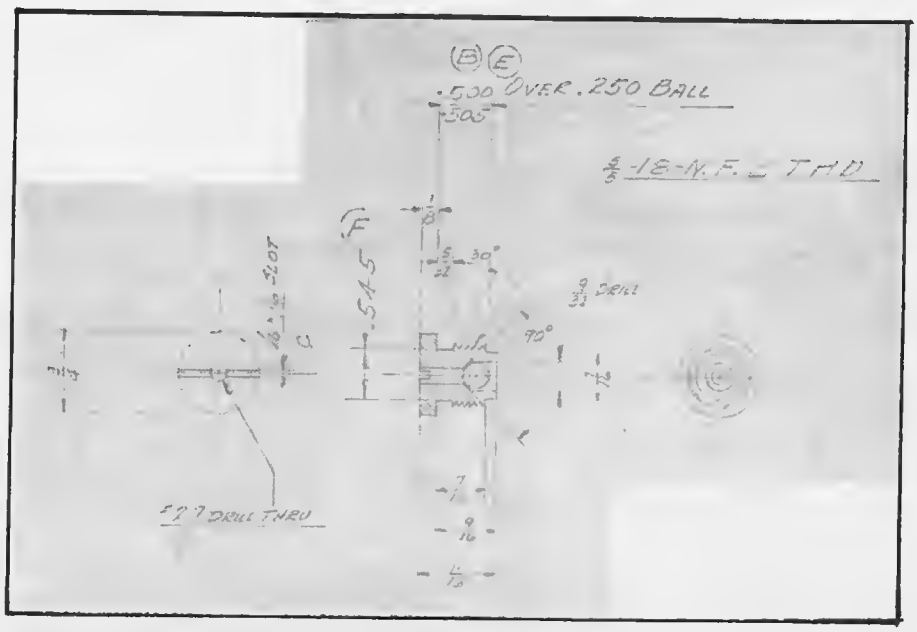


EXHIBIT 4b

"PRECISION" VALVE PILOT SECTION DETAILS

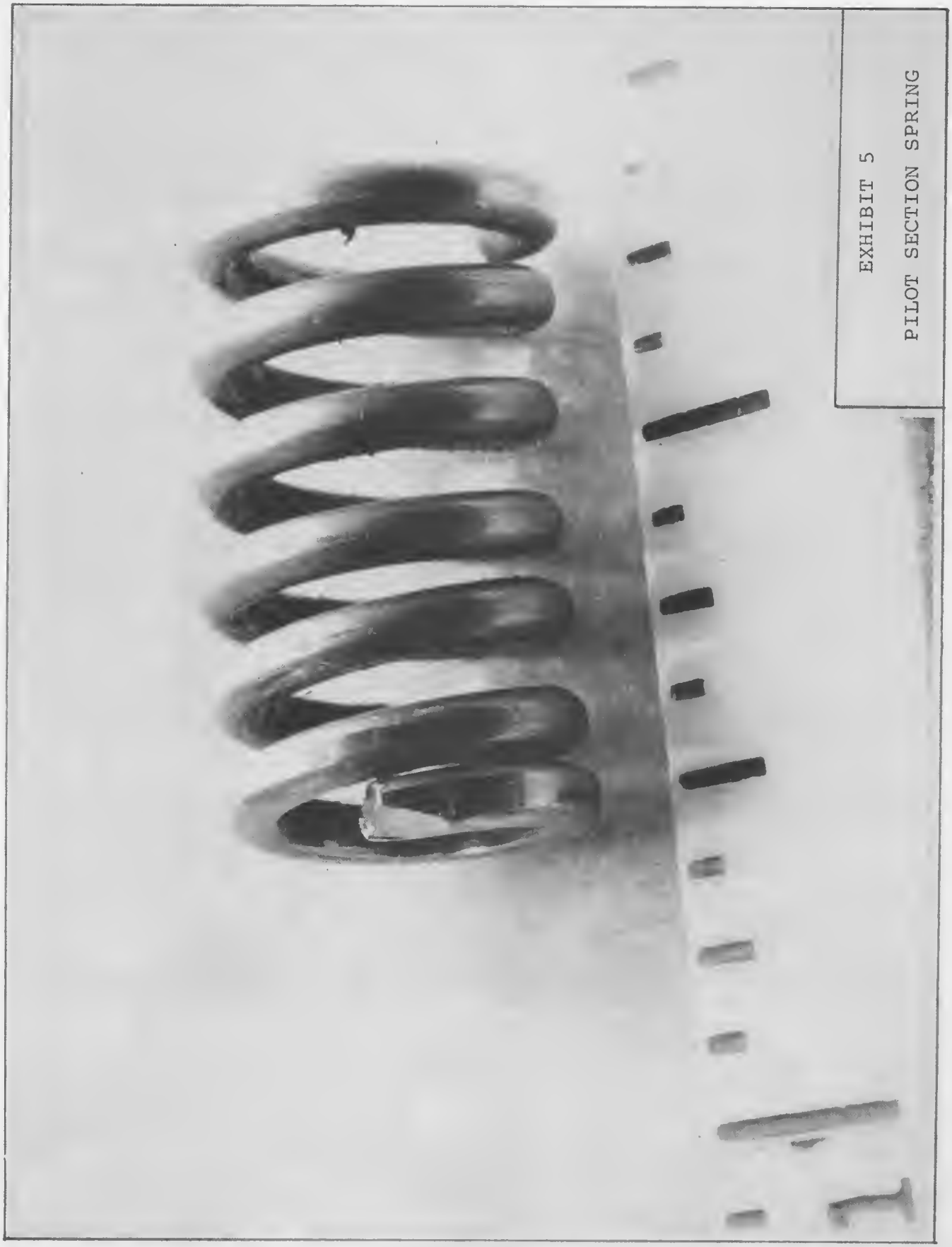


EXHIBIT 5

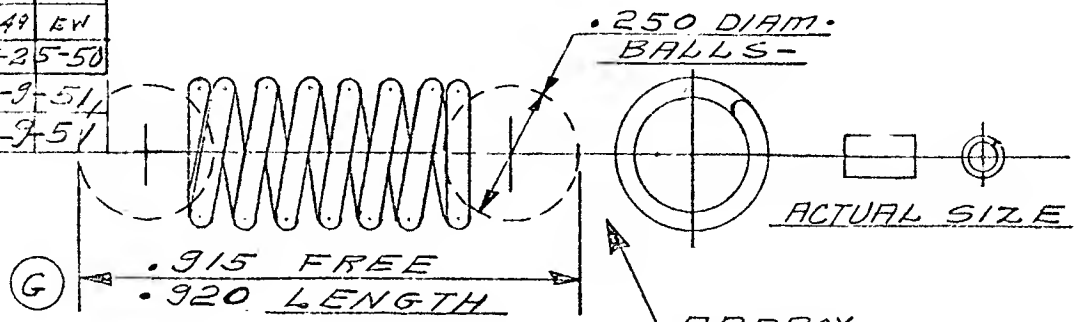
PILOT SECTION SPRING

EXHIBIT 6

SPRING FRAGMENT

LET.	CHANGE	DATE	BY
C	REVISED	12-	1448
D	WAS STAINLESS STL	10-49	EW
E	WAS PLAIN FINISH	10-49	EW
F	WAS NOT GROUND	5-25	5-50
G	DIMEN. ADDED	1-9-	51
H	NOTE REMOVED	1-9-	51

NOTE: TOLERANCES ON FRACTIONAL DIMENSIONS ± .010.
ON DECIMAL DIMENSIONS ± .003 UNLESS OTHERWISE NOTED



9/32 DIA. (FREE IN)

(D) .045 MUSIC WIRE

(F) CLOSED ENDS
GROUND-

(H).

3/8 MAX.-SOLID HEIGHT

9.5# TO 10.5# AT 27/64 LENGTH

(E) CADMIUM PLATE

	DRN.	CK'D	APPD.
DATE	5-14-48		
NAME			

EXHIBIT 7

PILOT SECTION SPRING
SPECIFICATIONS

SPRING

PATT. NO.		PART NO.
MAT'L	NOTED	1046
SCALE	———	

ECL 178A

ECL 178B

NEGLIGENCE (B)

After reviewing the material presented in Part A, Mr. Thomas phoned Mr. Freeman: "I think I've got an idea of what caused the failure, but I'd like to see the actual valve and broken spring. I've got some tests in mind that'll hopefully pinpoint the cause." Mr. Freeman arranged to send the valve and spring to Mr. Thomas' lab-workshop. Both men agreed that Mr. Thomas should also travel to Birmingham, Alabama to observe the subject press in operation.

While Mr. Thomas was conducting his tests, inspection, etc., Mr. Freeman was busily deposing other witnesses. A condensation of these depositions follows.

ZELENKA DEPOSITION

Mr. Reingard Zelenka began his career with the National Power Press Company in 1939 as a machine designer. He was successively promoted to Chief Draftsman, Assistant Chief Engineer, Chief Engineer of Research and Development, and Chief Engineer of Product Development. As a member of the National Safety Council Power Press and Forging Section Committee and the Joint Industrial Conference, he contributed numerous articles on press technology and helped establish safety codes for power presses. In 1967, after handling customer complaints of press malfunctions for several years, Mr. Zelenka was appointed Manager of Product Reliability. He briefly elaborated on this title in his deposition.

Q: (by Mr. Freeman): Is that by order of a particular officer of the company or board or policy statement or something along that line?

A: Not originally. It looked like I was a good fall guy.

Q: Excuse me?

A: It looked like I was a good fall guy at the time, that is how it started, and then it gradually grew into what I have now.

Q: Is that where the title "Product Reliability" comes in?

A: I assume so.

In February, 1948, National adopted the Precision Valve as its "standard" air control valve and continued its use until 1958. Mr. Freeman asked Mr. Zelenka if there was a standing memorandum or specifications in writing which called for the use of the Precision Valve. He replied, "I couldn't find any particular orders, we will say, or standard things. It could have been that there was a standards sheet which spelled it out, but I don't know where I would find it; but you will have to take my word for it that this was our standard." All National Press customers in that ten year period received Precision Valves unless they specified otherwise. However, close to half of all National presses built between 1948 and 1958 did have different brand valves installed at the request of numerous customers (including the Giant Motors Corporation).

Mr. Freeman then directed the questioning to Mr. Zelenka's handling of customer complaints. Mr. Freeman wanted to know precisely how National would respond to a customer reporting trouble with one of their presses. Mr. Zelenka replied, "Well, I suppose if he were to write a letter, he might receive a letter in return. If he were to request help, we may send someone out and there would be some service report." Mr. Zelenka recalled further that a lot of complaints came in by phone, and no record was kept of such calls. In fact, no file which classified written complaints or service reports by subject matter was ever maintained. Mr. Freeman then asked Mr. Zelenka if he could estimate the number of inquiries or complaints about the Precision Valve which National might have received between 1948 and 1958. Mr. Zelenka responded, "couldn't do it because where a person had complaints on the valves, and it needed repairs, as I said, we made no repairs, ourselves, and we referred them back to the manufacturer. We might put a note in there, 'we do not service these valves, don't have the parts,' send their letter back with a note in it, 'send it to the manufacturer'."

As the questioning continued, Mr. Zelenka noted that A.T. & D. had never informed him of Earl William's accident. In fact, the first time he had heard about it was when the attorney for Defendant National contacted him regarding the lawsuit.

Prior to his deposition, Mr. Zelenka had reviewed the depositions of Meister and Hayes (which were supplied by Mr. Simpson) and had formed an opinion as to what caused the accident. Mr. Freeman asked him to state this opinion, and Mr. Zelenka answered, ". . . The cause of the accident was due probably to the valve, itself, malfunctioning due to a portion of a spring being lodged for some short period of time, apparently, under the ball, so that it didn't respond as quickly as normal."

On the basis of this opinion, Mr. Zelenka had also conducted a test on an available Precision Valve to see if the broken spring fragment could, indeed, have caused the valve to malfunction. He placed a wire of diamater close to that of the spring through the orifice on which the solenoid ball seats to determine how this would affect the valve performance as the solenoid was energized and de-energized.

Q: (by Mr. Freeman): What happened?

A: Well, the valve would act erratically at certain points. Some places it seemed to have no effect, and then it went through a zone where it was erratic, and then it

went out of that area into an area where, say, it refused to function. So it went from a functioning point through a zone of, we will say, erratic behavior, like slow response and all this sort of thing.

Q: What did you conclude based upon your observations from that test?

A: Well, I concluded that a particle under the ball that would prevent it from seating in some . . . of some size could cause the valve to act sluggishly. This is the general conclusion I reached.

Q: After you ran this little test, did you take any steps to notify your users about this problem?

A: No, actually, not.

Q: Have you instituted a recall campaign on the Precision Valve?

A: No, we have not.

Q: Have you considered it?

A: Haven't found any actual evidence to support the fact there is any major problem existing.

The questioning turned to the life expectancy of the Precision Valve. Mr. Freeman asked whether National had ever conducted any tests or inspections of the valve. Mr. Zelenka said that some "performance tests relating to the transient response" of the valve had been made but stated that no life-tests had ever been performed, noting that "we relied on the manufacturer of the valve to put out a valve with good life."

Q: (by Mr. Freeman): What information, Mr. Zelenka, did your company have regarding the life of the valve?

A: Only what we would have expected of a well-constructed valve and what we might rely on from the manufacturer.

Precision Valve never supplied any such information and, in fact, never life-tested their own product. Mr. Zelenka defended the lack of a life-test by National, claiming that any such test under "controlled laboratory conditions" would be likely to yield misleading results.

The National Power Press Company had a standing policy of sending each customer a press manual which contained maintenance and replacement instructions regarding the clutch-brake unit, electrical controls, and other major press systems.

Q: (by Mr. Freeman): Mr. Zelenka, what, if anything, did your company tell the customers, either in your manual or in the instruction sheets or similar data, or in any way, regarding replacement of the valve and when the valve should be replaced?

A: I don't believe there is any reference in the manual as to the frequency at which a valve should be replaced.

Q: Do you make any reference in the manual to the fact that it ought to be inspected?

A: I wasn't able to find anything with reference to inspection.

Q: Mr. Zelenka, based on your understanding of this, and based on your manuals and the literature that goes along with this press, what should the customer do with reference to this valve, as far as replacing it?

A: I don't think the question is too clear.

Q: Well, let me ask you, is it correct that as far as your company is concerned, the customer may operate the press with the valve in it indefinitely?

A: No.

Q: What should the customer do then?

A: Any other machine requires normal preventative maintenance is the best I can say, and the valve is not excluded from it.

Q: What do you tell the customer in your manual with respect to preventative maintenance of the valve?

A: Nothing specific.

. . . . . .

Q: Isn't it true that at various points in your manual you refer specifically to parts of the press that should either be replaced or preventatively maintained?

A: Well, there is reference to replacement parts. In one case, where there is reference to electrical equipment, there is some indication that they might expect coils to burn out in control panel relays or starter coils.

Under lengthy questioning, Mr. Zelenka emphasized his belief that each of National's customers should have preventative maintenance programs with a schedule of rebuilding and replacement directed particularly to those parts subject to the greatest wear. However, he felt that National could not properly recommend how often parts should be replaced or rebuilt because they had no knowledge of how a customer was using a press (i.e., press work load, operating conditions involving air supply and lubrication, etc.). The customer, he claimed, was in a far better position than National to judge his own maintenance needs by virtue of his own operating experience. Mr. Zelenka acknowledged that he was unaware of the details of any preventative maintenance program that any of National's customers may have been using, only that some were "excellent" and others "lousy". Mr. Freeman then reminded Mr. Zelenka that in 1954, Precision Valve Co. had sent a sheet of maintenance instructions to National. He recalled that National did not distribute these instructions to their customers simply because they had not received them in quantity from Precision Valve Co. Mr. Freeman finally urged a reluctant Mr. Zelenka to give his opinion as to how often presses should be inspected:

A: Oh, I would expect that any press gets a thorough inspection once a year.

Q: And in that thorough inspection a valve should be disassembled, as you have indicated, and cleaned?

A: I would say anything associated with the controls of the press should receive, at least, yearly, during some down period, a completely thorough inspection.

Q: What is the cost of the valve?

A: Thirty-five dollars. You can't look at a valve for $35.00.

Q: How often would you replace the valve on a press?

A: I would replace it myself, once every couple years, myself, I believe . . . I imagine five years is a pretty good life on a valve, the way it is, with . . . I would say it had seen enough service that you might as well retire it and get yourself a new one, my own personal feeling would be. But this is dictated by company policy

and everything else. And whether or not they would permit you to make these kind of expenditures is, again, something that . . .

Q: Thirty-five dollars every five years?

A: You would be surprised how they pinch their pennies and throw the dollars away.

Q: What is the approximate cost if a customer - let's suppose in 1960 a customer in Cincinnati asks you to go out and inspect a press in Houston for purposes of determining whether or not they should buy it, whether it would be an adequate piece of equipment for their use, what would that, just in general, what would that cost the company in Cincinnati to do that?

A: So much per day.

Q: What would the outside cost of that be, in your estimation?

A: It depends on what he drinks, I guess - - no, actually, let's say, it covers daily expenses, his travel time and his per day charge. It might amount to a couple hundred dollars, let's say. It could vary depending upon the size of the machine and what he runs into.

* * * * *

LUCAS DEPOSITION

Mr. Harry Lucas worked for the National Power Press Company from 1946 to 1952, starting as an electrical engineer in the Engineering Department and later transferring to the manufacturing section as plant engineer, then master mechanic and finally works manager. He left National to become the manager of electrical engineering for another firm. Contrary to Mr. Zelenka's testimony, Mr. Lucas claimed that he had personally life-tested the Precision Valve in February, 1948, prior to its adoption as a "standard" by National.

Q: (by Mr. Simpson): Now, you have indicated that you have made an investigation on the Precision Valve. Do you want to tell us what you did, sir?

A: We set up a cycling test with a small cam operating a limit switch, and the limit switch energizing and de-energizing the valve, simply to operate it. The valve,

of course, was connected to the air line, and the output of the valve was into, probably, a small tank or something that doesn't use a lot of air, anyway. Just check its operation.

Q; All right. Do you know whether you ran any type of life test on it?

A: Yes, that was about what we did. We had a pressure switch on the container that we were putting air into, and the contacts of the pressure switch were connected to an electric counter, so we just set the cam driver to running and counted the number of operations.

. . .

Mr. Lucas ran the test for "something over a million operations" at a rate of "somewhere around 100 cycles a minute", twenty-four hours a day. Since he had neglected to make any permanent record of the test, other than to log the number of cycles each day, Mr. Lucas' testimony relied entirely upon his recollection. He recalled that when he inspected the valve after a million cycles, he could find no "appreciable signs of wear" and discontinued the test because the "popping noise" it caused was annoying other employees.

Mr. Freeman decided to pursue some details of Mr. Lucas' alleged test.

Q: (by Mr. Freeman): You tested one valve?

A: Yes.

Q: And only one valve?

A: I believe so, yes.

Q: Where did you get that valve?

A: I don't know.

Q: Who got it for you?

A: I don't know that either . .

Q: Well, is it possible that Precision Valve Company supplied you with that particular valve for the test?

A: Anything is possible.

Q: Is it possible that your company might have told Precision Valve that you wanted to test their valve?

A: Sure.

Q: And then they would have supplied it to you for that purpose, right?

A: Yes.

. . . . . .

Q: Now, prior to conducting this test on this Precision Valve, had you ever tested any valve before?

A: No.

Q: Are you a valve expert?

A: No.

Q: Where did you get the information as to how you go about testing a valve like this?

A: This is - what would you call it -- common knowledge.

Q: Did you make any bubble tests for leaks on the valve?

A: No.

Q: Or any other tests for leaks other than the life test that you have already indicated?

A: No.

Furthermore, the Precision Valve which Mr. Lucas tested had a ground spring in its pilot section, whereas the production valves installed on National presses between 1948 and 1950 contained unground springs.

Q: (by Mr. Freeman): Now, did you make any determination as to how a Precision Valve - - how that valve would fail, if it failed?

A: No, we didn't make any determination of how it would fail. We couldn't get it to fail.

Q: You didn't make any determination as to whether or not this valve, if it did fail, would fail safe or unsafe? I am talking about the Precision Valve.

A: We assumed that it would fail safe.

Q: But you didn't know, did you?

A: We couldn't imagine any way that it would fail unsafe, let's say it that way.

Q: You didn't actually investigate that question, did you?

A: No. When you can't get it to fail at all, well, it is pretty hard to say how it is going to fail.

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SARGENT DEPOSITION

Mr. Lloyd Sargent joined the Precision Valve Company in 1946 at about the time the young company was incorporating. Co-owner and president, R. H. Lowell, had guided the fledgling company from 1941-1946 and in 1944 had invented the particular valve involved in this case. Mr. Lowell was the only engineer ("by experience") ever associated with Precision Valve from 1941 to date (1968). Mr. Sargent was placed in charge of manufacturing for Precision Valve, a position which he held until 1962, at which time he resigned and sold his interests in the company.

Q: (by Mr. O'Brien): Now, do you recall that from time to time back in, say, '48, '50, along in there, that valves that you sold were returned by various poeple for re-building?

A: Right.

Q: How many would you get in the course of a week or month, do you have any idea? Just as near as you can tell without - - or if you can put it this way, what percentage of your production would come back to you?

A: Oh, I will take a quick estimate of two, three a day, perhaps. Something like that.

Q: What would they come back for? What would be some of the reasons?

A: Oh, some of them were mechanically damaged, damaged by accident, hit by a lift truck or something like that. Others would be full of dirt, depending on how they are used, fiberglass or asphalt or Lord knows what. Some of them actually had missing parts.

Q: Any occasion when the spring would be worn to the point where they needed replacement?

A: The springs we replace automatically. I don't recall any particular problem with springs. One came back with a peach pit in it.

In subsequent questioning, Mr. Sargent estimated that the Precision Valve should have a lifetime in excess of five million operations under "recommended installation" and even in "pretty lousy" shop conditions, which he described as typical. The questioning then turned to the recurring topic of valve maintenance and inspection.

Q: (by Mr. Freeman): Suppose a press manufacturer buys this type of valve from Precision and mounts it on one of the power presses that he is selling to the trade, should the press manufacturer, in the normal course of his business, advise his customers as to what to do as far as maintenance of this valve is concerned?

A: Well, I can only assume that he would have an instruction manual of some sort that would cover the area of valve maintenance.

Q: All right. How does a user of a power press with one of these valves mounted on it determine the life of a valve as far as replacement or rebuilding that valve is concerned?

A: No, I would have no way of determining that, how he would tell, except, perhaps, by the number of hits it makes over some such period of time.

Q: Is there a time when he should replace the valve?

A: I wouldn't say so, no.

Q: You mean he can keep that valve indefinitely; is that the idea?

A: The particular nature of this valve should be a fail-safe valve. In other words, any malfunction of the valve should not actuate anything. So if the valve didn't work, why, he would find it out in a hurry. But as far as gradual wearing out of it, I don't believe there is any such thing.

Q: In other words, if the valve failed, he would be able to see that right away because the machine would malfunction?

A: It wouldn't malfunction; it wouldn't function.

Q: So that, therefore, there is no particular time when a user of the valve needs to worry about replacing it until the press actually fails?

A: Well, I wouldn't say that. You should have periodic maintenance just as you service your car. You have to grease, lubricate, and inspect any mechanical machine.

Q: As far as you know, Mr. Sargent, was your company advising its customers that it could utilize this valve on various types of equipment indefinitely, and that if any failure occurred, why, the failure would - nothing would happen because the valve is fail- safe? Were you telling your customers that?

A: Not to my knowledge, no. Not as a matter of policy or anything like that certainly. What the salesman might have said, I don't know. But, basically, it is a fail-safe design for use in the normal press, clutch operation.

Q: Was it commonly understood in your company that it was a fail-safe design?

A: I would say so.

Q: Let me ask you this, Mr. Sargent, suppose that this particular valve that we are concerned with was manufactured in 1949 by Precision Valve, and put on a National press, which was utilized for ten years by a customer in Houston doing light work on the press, and that in 1960 it was re-purchased, suppose at that time that the new purchaser of the press, in 1960, were to call up Precision Valve and say, look, I am going to buy a National Press, and it has a Precision Valve on it, can I continue to use this valve, or should I send it back to you, rebuild it, or what, what would you have told them?

A: Well, it is a hypothetical question. I believe I would have told them to send it back and we would rebuild it.

Q: Why?

A: Just because of the fact of the period of time it's been in use, or its age. I don't know how long it's been used.

Q: Assuming it's been used ten years?

A: I would say it was time for an overhaul.

Mr. Freeman then asked Mr. Sargent to explain the changes in the Precision valve pilot section spring specifications as noted in the drawing shown in Exhibit 7 of Part A. Mr. Sargent recalled that the change of spring material from stainless steel to music wire (10-49) was made to increase spring rate. The increased rate, he claimed, was necessary to overcome sluggishness of the spring in returning the solenoid ball to seat when the valve was required to cycle rapidly. Mr. Sargent next explained that the spring was changed from unground to ground (5-50) to obtain ball seating more closely concentric with the spring axis.

Q: (by Mr. O'Brien): Now, let's take the three-way valve (the Precision valve) with the one spring and the two balls, so far as the seating of the balls at each end of that spring in the three-way valve, as I understand your testimony, it is better to have the balls seat in each end of the spring as concentrically as possible; is that right?

A: Right.

Q: And the reason for that is that the orifices are likely to be closed more securely when the spring is in its extended position?

A: More rapidly, I would say, "more securely" might be useable.

Q: Would there be a possibility, at least, that if the balls didn't seat concentrically or as nearly perfectly concentrically as possible in the spring, that there would be a possibility that the orifice that the ball closed wouldn't completely close?

A: That is a possibility, yes.

Q: You found out, one way or another, that you could achieve a more concentric seating through use of a ground spring as opposed to an unground spring?

A: That is correct.

Q: Keeping that in mind, wouldn't it be true that so far as an unground spring is concerned, where the ball wouldn't be seated concentrically, that you are likely to

get more stress on the spring in a certain part of it as opposed to, say, a concentrically seated ball where the whole spring would take the stress it was getting, as if the seating wasn't proper, then one part of the spring might receive more stress than it should; is that right? If you follow me? I am getting unclear myself.

A: You are getting down to some awfully fine points. It is possible, certainly, because in the unground end your ball is only touching two points at any time.

Q: Whereas in the ground end - -?

A: Whereas in the ground end you have a partial circumferential seating.

Q: But that being true, it is likely, at least, that with the ground spring you get a spread more likely over the whole spring, whereas in the unground spring you would get stress on parts of it, more stress; isn't that true?

A: You are getting down pretty fine. I don't know how you would measure it.

Q: But that is certainly a physical fact, isn't it?

A: That is a physical fact, yes.

Originally (1947-1948), ground springs were used in the Precision Valve (at a cost of 3¢ each). Between 1948 and 1950, unground springs (at a cost of 0.7¢ each were used), and then ground springs (at a cost of 1.3¢ each) were again used after 1950.

Q: (by Mr. Cunningham): Can you think of any reason why you might have gone from ground to unground and back to ground again other than the price factor?

A: No, I don't know why we ever went to the unground, very frankly.

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ABRAM DEPOSITION

Mr. David Abram, Chief Engineer of the United Spring Corporation, had specialized in the metallurgy, design, and manufacture of springs since 1937. He participated in the writing of spring standards for the ASME, ASTM, and the Spring Manufacturers Institute, and, in addition, served as president of the Connecticut Chapter of S.M.I. for the 1962-1963 term.

Mr. Abram was handed a copy of the Precision Valve spring blueprint (previously shown in Exhibit 7 of Part A) for reference as the following questioning began.

Q: (by Mr. Freeman): Now in the normal course of operation of the engineering department, if a drawing like this comes in to you from a customer, what would be your procedure in supplying the customer with the spring?

A: Well, our normal procedure would be to bring it into the engineering department and go over the calculations on the drawing, and if we felt that, or if the design was such that the stresses were extremely high, we would normally call this to the customer's attention and find out whether this was acceptable or not. However, if it was of a safe design, we would probably process it right through and manufacture parts. Our practice normally, is, particularly on a new item, the first order in, we submit production samples for customer approval before we produce or mass produce the part.

Mr. Abram noted however, that the calculation of the spring stress on the basis of the loading specified on the customer's drawing can be troublesome: "Sometimes the customer is reluctant to furnish us with all the information. We find many times that what they specify on the drawing is not what the application is finally."

Q: (by Mr. Freeman): Okay, now, with reference to this particular diagram, how would you go about computing the stresses to be applied on this spring, examining the document and taking into consideration the specifications given there, including the diameter of the coil and the diameter of the wire and load?

A: Well, you have certain specifications on this document that allow you to do only certain things. You have a free length tied down to five thousandths. You have a load at a given height that ties you down to one pound. Now, this automatically establishes a rate. You have a diameter that you have to live with, and into that space

then, you have to establish a wire size and a number of coils to give you the proper rate and load within this area.

Q: What I am asking you to do, is, would you proceed to calculate, using that information, the stress which would be applicable to this spring?

A: Tell you what I will do, I will send down a folder to you and it will probably take less time.

Q: You know what the formula is, don't you?

A: Sure I know what the formula is.

Q: Well, go ahead. Just figure it out real fast for us so that we can get on and ask a few more questions about it. That is my point.

A: You want to know what the stress is actually?

Q: Yes, you can use a pencil and paper.

A: Why don't you give me a telephone and I will get it a lot faster.

During a brief recess, Mr. Abram telephoned his company and gave an assistant the spring specifications. With the aid of a computer, the assistant determined the stress induced in the spring and quickly relayed the answer to Mr. Abram.

A: The stress would be 85,000 psi, which would be approximately 60% of the yield, which is very safe.

Q: (by Mr. Freeman): How does the computer assume the load is being applied to the spring? Do you understand what I mean?

A: I could go into great detail and I don't think you would know what I was talking about anyway, so if you came down to the plant I could give you a typical example of it and we would quit wasting a lot of time . . . I think it is immaterial to the case myself.

Mr. Schultz: I will object to it on the basis of immateriality.

Mr. Freeman: It most certainly is not immaterial at all. We are talking about the characteristics and properties of the spring.

Mr. Cunningham: I would like to know, frankly, what you are driving at, Mr. Freeman. If you are trying to now find out from him - -

A. (Witness): You can't find out from me how it is going to fail by calculations.

Q: (by Mr. Freeman): My question is this, looking at this document, how do you ascertain how the force is being applied to the spring?

A: I don't know except I have to assume that at either one end or the other he is going to apply some force.

Q: Is that what the computer assumes when you come up with a figure of 85,000 pounds per square inch?

A: The computer does exactly what I tell it to do.

Q: I know. My question to you is, does the computer assume that the - -

A: The computer doesn't assume anything.

Q: Do you tell the computer then that the spring is loaded in direct compression loading?

A: That is right.

Q: All right. Now, what is the endurance strength of the material we are talking about, and we are talking about stainless steel?

A: Well, that is an ambiguous question.

Q: What additional do you have to know in order to compute it?

A: Well, we have charts that have been established by experience over the years, that give us an indication of what we can expect. It doesn't necessarily mean that this is the case every time because . .

Q: I appreciate that.

A: When we assume these things, we are talking about perfect material and perfect everything, which we can't assume when we are talking about a specific part.

Q: What do you assume in the ordinary specifications for stainless steel wire of this type, for use in this type of a compression spring, what would the endurance strength be, expressed in psi?

A: Could possibly be 110,000 or maybe even greater.

Mr. Freeman then asked whether the spring stresses would differ depending on whether loading was through a plate or a ball. Mr. Abram replied, "I doubt whether it would make a great deal of difference. There could be some bending stresses between plates, particularly on a spring that isn't ground. If it was ground, I wouldn't expect it would be a great deal."

Q: (by Mr. Freeman): Do you know whether or not the use of a ball nested at the end of this spring would introduce a bending moment into the spring?

A: I don't know.

Q: How would you be able to calculate that?

A: It would be a little difficult. You would probably have to have some pretty fancy devices, strain gauges, and so forth, to be able to measure deflection that occurs because of the ball.

Mr. Freeman next exhibited the broken spring and fragment from the Precision Valve. See Exhibits 5 and 6 of Part A.

Q: (by Mr. Freeman): Let me direct your attention to the spring. In your judgment should a spring of this type, loaded with the balls depicted in the diagram which you have in front of you, should a bending moment be excluded, if possible, from the design of the spring and the ball assembly?

Mr. Schultz: I will object on the basis that there are too many unknowns, imponderables, and too many variations in application of this spring for any witness to answer such a question.

Mr. Cunningham: I make the same objection.

Mr. Simpson: Same objection.

Mr. Schultz: Now you have to answer the question, Mr. Abram, if you can.

The Witness: I couldn't answer it. I think it would take . . . this off the record?

Mr. Cunningham: No.

The Witness: Then I won't answer it.

Q: (by Mr. Freeman): Wouldn't it be a fair statement to say you tried to minimize the stress in the material as far as possible?

A: As far as possible, yes.

Q: Right. Wouldn't it also be a fair statement that, in designing springs of this general type, you try to avoid the introduction of a bending moment into your load?

Mr. Schultz: Same objection.

A: I am not sure that we have any.

Q: (by Mr. Freeman): Assuming - -

A: I am not going to assume anything from this point.

Q: Whether we have any or not, isn't it true that you try to avoid that?

A: Normally.

Q: (by Mr. Schultz): The spring shown in the diagram indicates a squared end; is that correct?

A: It so states that the end should be closed.

Q: The purpose of that is to provide a level loading surface for the spring, isn't it?

A: Exactly. Right.

Q: So that the purpose of having that spring specified in that fashion would be to eliminate as much as possible any bending moment, wouldn't it, or to provide a level load?

A: I would assume so.

Next, Mr. Abram examined the failure surface of the spring with a magnifying glass.

Q: (by Mr. Freeman): What kind of a failure does it look like to you?

A: I wouldn't be able to begin to tell you with the equipment we have at hand.

Q: What was your first impression?

A: I didn't have any first impressions.

Q: Does it look like a fatigue surface to you?

A: I can't see it well enough to say yes or no.

Mr. Abram's deposition concluded with a brief discussion of spring replacement scheduling.

Q. (by Mr. Freeman): Assuming that this spring is going to be in a critical place in a piece of equipment, and I mean by that, that if the spring fails, you have a failure which endangers life or limb, the failure of a piece of equipment, how often should the spring be replaced, if at all?

A: Well, I think that should be determined by the manufacturer of the end product rather than by the spring manufacturer.

Q: But let's suppose you sell it to an air valve manufacturer, right? Do you understand what I mean by an air valve - - don't you? Have you ever seen an air valve?

Mr. Simpson: Today he did.

Q: Before today.

A: Oh, I have seen one or two along the way, yes.

Q: Let's be serious, Mr. Witness. This is a serious case, I mean, in terms of the injury to the man. You understand this, don't you?

Mr. Cunningham: I understand the witness has been very serious.

Mr. Freeman: Let the record show that the witness winked.

Mr. Simpson: I don't know, it might be from fatigue.

Q: (by Mr. Freeman): Let's suppose I am the user and I know it has run one million cycles, when do I know when to replace the spring?

A: I wouldn't have - - you wouldn't have - - I wouldn't have any idea because you have - - how many parts do we have in the valve?

Q: Let's say we have 50 parts in the valve?

A: Well, perhaps the malfunction of one of the other parts of it would have some reflection on the spring.

Q: Are you saying, sir, that the user, the consumer of this press would have no idea when to inspect or replace the spring?

A: I would assume that possibly some type of cycle test had been run on the valve and possibly some life expectancy has been established.

Q: For the spring or the valve as a whole?

A: For the whole assembly.

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NEGLIGENCE (C)

After finishing his calculations and tests, Mr. Thomas called Mr. Freeman to report that he was ready to testify. He listened attentively as Mr. Freeman described Mr. Zelenka's test and Mr. Abram's calculations. Mr. Freeman arranged for a deposition to be taken a week later, the essence of which follows.

Q. (by Mr. Simpson): Now, Mr. Thomas, you are well aware, I know, of the accident involving Earl Williams that happened back in '64?

A: I have knowledge of it, yes, sir.

Q: Did you make any investigation of this accident, yourself, sir?

A: Yes, sir.

Q: Do you want to tell us what your investigation consisted of?

A: One, I read quite a number of depositions of people who were either present at various times associated before or after the accident . . . I looked at drawings of the valve which were made by Precision Valve Company and blueprints and various operations and maintenance sheets of the National company . . . I took a trip to Birmingham, Alabama, to observe the, as I understand, what was the subject press in operation, and examined it. . . I inspected the Precision Valve which, I understand, was the valve on the press at the time of the accident . . .

I made various calculations involving loads, stresses, that would be developed in the pilot spring and, essentially, analyzed the valve in its function on the press from the standpoint of determining, in my opinion, as to its suitability, its limitations, and its interrelationship with the press.

Mr. Thomas then described the set-up which he had devised for testing the Precision Valve: "I hooked the valve up to line air. I hooked a small air cylinder up to the work outlet, which would have been the port which went to the valve operating the clutch-brake arrangement on the press and proceeded to operate the valve by depressing what I would call the solenoid push rod."

Q. (by Mr. Cunningham): What did you use for balls and spring?

A: I used the two quarter inch diameter balls . . . and I used the spring which had been taken off the valve.

Q. (by Mr. Schultz): You mean the broken spring?

A: The broken spring.

Q: Then you assembled the whole valve, including the pilot section?

A: I left out the small piece of spring. I didn't put that in. I was afraid I would lose it everytime I touched it.

Q: Then what did you do?

A: I opened the valve. (opened = operated)

Q: What happened?

A: It worked.

Q: Did you operate it once or more than once?

A: I operated it a number of times.

Q: Were you able to get it to fail in that condition without doing anything more?

A: No, sir.

Q: Into which end did you put the broken spring? Did you

put it toward the end plate or toward the solenoid?

A: I tried it both ways. It made no difference.

Q: It worked both ways properly, right?

A: Yes, sir.

Mr. Thomas recalled that he next introduced wires of different diameters under the pilot section balls to hold them off seat as he tried to operate the valve.

Q. (by Mr. Schultz): What happened?

A: With regard to the solenoid ball - I used two sizes of wire, one was .008 in diameter and the other was .025, as I recall. I put the .008 diameter wire underneath the solenoid ball and it didn't seem to make much difference, it seemed to go ahead and work, actually.

Q: Even when you held it (solenoid ball) off seat, it still worked?

A: I am telling you what I saw. I couldn't say that there might have been some leakage but, nevertheless, it was of an amount that the valve would still function.

Q: Then what did you do?

A: Then I used the .025 diameter wire, and this held it off so that the valve wouldn't function. What I mean by that, it prevented any pressurization of the pilot chamber by holding it off seat.

Mr. Schultz then suggested that the broken spring fragment should have been forced out of the pilot vent by air pressure. Mr. Thomas claimed that this was impossible because the clearance between the bore of the pilot (.285) and the quarter inch ball would not permit a fragment of .045 to pass through. Mr. Schultz countered by saying that if the spring fragment did indeed hold the ball off seat, then certainly it must have passed behind the ball. Mr. Thomas suggested that the fragment could not get past the ball but could hold it off seat by wedging between the ball and the bore.

Q. (by Mr. Schultz): Any other tests with this particular valve?

A: I was interested in the action of the valve under a condition of effective jam, one in which the spring would be bearing against the end plate ball and various modifications of this location, and I ran tests of this nature by means of pushing the spring-ball assembly over against the end plate, seating the end-plate ball, and then releasing it, which would actuate the valve into the engaged position, let's say, where the clutch would have been energized, and in this case the press would cycle from this energization. Then I was interested in the reaction, the action of the valve as I backed off from this position, and I did so and observed the results.

Q: And what were they?

A: I observed in this particular configuration you get a condition whereby air would pass around the end plate ball, which pressurized the pilot chamber to some extent and resulted in a slight shift - - this is the only way I can describe it - - of the main spool, which gave exhausting and load pressure at the same time.

Mr. Thomas then noted that in an additional test he had replaced the spring in the pilot section with a short, rigid tube, and the valve still functioned properly. This remark failed to provoke discussion.

The questioning turned to Mr. Thomas' examination of the failure area of the spring (under a low power, illuminating microscope).

Q. (by Mr. Schultz): Did the general appearance of the break area indicate to you whether this was an impact fracture or a fatigue failure or could you tell?

A: Well, in the application, it would have been subject to a number of cycles, and my opinion was that it would have failed from a fatigue, primarily, in bending.

Q: What in its appearance led you to believe that it was a fatigue failure from bending?

A: The appearance of the break area. The contrast between the inner surface or the inner radius area and the outer radius area.

Mr. Thomas commented further that the chamfering (visible on the spring fragment) did not, in his opinion, influence the fatigue failure.

In a subsequent lengthy period of questioning, several defense attorneys pointed out that if the valve malfunctioned and the clutch remained engaged, then: (1) how could the ram have come to a stop at top stroke before its repeat? and (2) what caused it to stop after it hit Earl Williams arms. Mr. Thomas replied that the press could have acted in such a manner if (a) the source of the ball being held off seat was dislodged or (b) the air pressure to the clutch (due to the valve malfunction) was reduced to the point where the clutch was slipping so that it would stop at the top, then grab again, and then stop at the bottom. Mr. Thomas explained, "Slipping is a relative term. It could be slipping all the time. In other words, it could be slipping and driving at the same time. It could be slipping completely so it doesn't move at all. This is a relative term, and this is the way that clutch will operate."

The attorneys then asked how, if the valve was malfunctioning, could the ram have been "inched" off Earl Williams' arms, since the "inch" press function operates through the air control valve to control brief clutch engagements and disengagements. Mr. Thomas speculated that the use of the "inch" button after the accident did not actuate real "inching". Instead he suggested that if the clutch was indeed slipping, then it could have "crept" upwards and, in so doing, resembled "inching." But Mr. Schultz was not satisfied with this explanation.

Q. (by Mr. Schultz): Okay. Now, assuming that they did just what I told you they did, inched this off his arms, inched the ram off his arms by activating the press by using the inch button, and inching the ram up, is it or is it not true that the inch button raises the ram by activating the solenoid in the pilot section of the valve?

A: Yes, sir, that is the normal operation of it.

Q: Assume that this failure occurred, as you have indicated. Now, is this a transitory failure or is it one that is going to stay there until they fix it?

A: I think "indeterminate" would be a better word because I can't say exactly what it was, but it could be something there that would stay there until they fixed it up, yes.

A: All right.

Mr. Schultz then directed the questioning to the pilot section spring.

Q. (by Mr. Schultz): Did you conduct any tests to determine the stress that would be applied to the spring in this valve?

A: No, sir.

Q: I take it that you do not have an opinion as to whether or not this particular spring was over-stressed or not?

A: I have an opinion.

Q: What is your opinion?

A: That it was over-stressed.

Q: Oh! On what basis?

A: A stress analysis which I made.

Q: Tell us exactly what you did in the way of stress analysis?

A: There are two factors with regard to this spring: one, you might say, is the basic stress, which involves the dimensions of the spring and the amount of deflection of the spring, this being basically, a compression spring . . . there is a second area that is of concern here, and that is the action of the balls on the end coil, the end turn of the spring . . . There is a relationship between the ball and the way it sits in the spring, itself, which takes into account the diameter of the wire and the inside diameter of the spring. The end ball, under the axial load of compression, also causes the end turn to be expanded outwards. This can also be related to the total axial load in terms of radial load, which I did, and from this I am able to calculate the stress based upon the material which involves certain mechanical properties, modulus of elasticity, and modulus of rigidity.

Mr. Thomas figured that the stress for an unground spring would be about 80,000 to 100,000 psi, whereas for a ground spring, it would probably be between 60,000 to 70,000 psi.

Q. (by Mr. Cunningham): Now, what do the balls have to do with effecting the stress?

A: They fit into the end turn, and, essentially, wedge out, try to expand the end turn, which causes a radial force to be exerted on the end turn of the spring.

Q: Now, were you able to make any calculations as to how many that was?

A: Yes, sir.

Q: What was it?

A: It was about a one-to-one ratio. In other words, it would be a total of ten pounds radial to ten pounds axial.

Q: What difference does it make whether the ends are ground or unground?

A: The difference is in the location of the radial load, primarily. Also it could have some effect on the axial, but, primarily, the radial load. If the ball doesn't seat at, say, two spots, and since there is a wedging effect at these two spots, this wedging effect gives a radial force. Now, if the end of the spring is the highest most point which is closest to the ball, you would have the ball coming in contact with the end of the spring, and then at about 180° opposite to it, and you would get a wedging effect on the end coil pushing out the free end of the spring on the opposite side, and it would be a wishbone-type of action, leaving the maximum moment at about 90° or right where the spring failed.

Q: All right. Now, if you had a ground spring, you wouldn't have as much of that effect, would you?

A: You would have a uniform seating and this load would be distributed all the way around. You would still have the ten pound radial load, but, instead of being concentrated so it could give a maximum moment at one section, it would be distributed all the way around and the stress would be less.

Q: Then you would be stressing against a much thinner and narrower piece of wire while you were doing that, wouldn't you?

A: This depends on how much grinding you do, and it depends on how you give it an end treatment as to whether you blunt it off. I am not saying that you just grind it off and forget it; I am saying that you give some consideration to all of the aspects.

Mr. Thomas next estimated (on the basis of previous calculations) that the pilot section spring should have a median life of about 1 million cycles. He noted, however, that if the radial force applied by the balls could be removed, then the life of the spring would probably increase to 4-5 million cycles.

Mr. Thomas was then asked to comment on the design of the Precision valve.

Q. (by Mr. Garibaldi): Well, you have examined this particular valve?

A: Yes, sir.

Q: As a matter of fact, you talked about it functioning properly. Did you notice anything irregular about its design?

A: I noticed that it had a spring in the pilot section, and in my opinion that is subject to failure.

Q: Anything else?

A: Yes, I did notice a few other things, basically. The arrangement of the valve is such that the force tending to unseat the ball from the end plate side is very small as compared with forces that exhaust it to seat. In other words the action initiating the press is handled by the positive action of the solenoid that pokes the ball in and over; but the action that disengages the clutch on the press is at, you might say, the mercy of about one and one half pounds of force coming through and acting on that end plate ball; and if there is anything that wedges or jams it at that point, it won't push off; and it seems a little unusual to me that this critical an item would be so feebly returned.

Mr. Cunningham was still confused by Mr. Thomas' testimony about how the broken fragment could have caused the valve malfunction and asked for some clarification.

Q. (by Mr. Cunningham): Okay. Now, on this clearance again, between the chamber - - the bore of the chamber and the diameter of the ball, my note here is that you found the clearance to be .035 inches?

A: It is going to vary but that is a nominal dimension, yes, sir.

Q: And the narrowest point on the fragment of the spring was what again?

A: Right at the point where it was chamfered, as it was called, at the end, I got .025. That was the smallest dimension across the cross section of the spring that I found.

Q: Apart from the chamfering, what was the smallest dimension?

A: .040.

Q: Okay. Then if the spring had not been chamfered, it could not have gotten in that clearance, could it?

A: It would appear that it couldn't get past the ball.

Q: There is not enough room for it to go?

A: To go past the ball and go through, yes, sir.

Q: So if the spring had not been chamfered, this accident couldn't have happened, could it?

A: No, sir, I don't say that. I didn't relate this to the chamfer at all.

Q: Well, how can you get a wire of that size and a clearance of that much without chamfering?

A: I haven't said that it has gone down there. It can wedge up against the ball and the side of the bore. I mean, the ball is curved and the bore is at the side and it will come in and rest on the bore . . the part is capable of being up against the ball in any position. It is capable of wedging underneath the turns of the spring. It is capable of wedging from the inside of the ball up to a turn of the spring. It is capable of wedging down into the crevice formed by the ball and the seat.

Q: Well, now, you are saying that the broken end of the spring did not, necessarily, wedge between the ball and the bore of the chamber but wedged somewhere else?

A: It might

Q: Where could it?

A: It wedged on a turn of the spring.

Q: How did that keep the ball from going back on seat?

A: It would catch and prevent the ball from being pushed on back.

Mr. Freeman: You have your balls mixed up there, Richard.

Mr. Cunningham: Well, I am unable to understand the whole basis of his testimony which, as I understand it, was that the broken fragment of the spring kept the ball from going back on seat . .

Q. (by Cunningham): . . . That is it, isn't it?

A: No, sir.

Q: Well, what is it then?

A: It is that the broken fragment caused a wedging and jamming action in the pilot chamber that prevented the ball on the plate-side from completely coming off of its seat; just the opposite ball and the opposite action.

Q: Was it, in your opinion, inevitable that after the break it would wedge in there and cause the valve to malfunction?

A: It is my feeling that it would, yes.

Q: You wouldn't agree then, that that was just a freak, a one in a million or ten in a million chance?

A: No, sir. I think this would happen and would happen more than this one time.

Q: What would be your basis for that?

A: That I expect the spring to break.

Q: Now, this is based on opinion and calculation? This is all based on opinion and calculations and not experience, is it not?

A: I wouldn't say that. It is based on a hell of a lot of experience.

Q. (by Mr. Cunningham): Now, these tests you have testified to at some length, did you make those tests for the purpose of arriving at your opinion or for the purpose of verifying your opinion after you had already arrived at it?

A: I made the tests to determine how the valve would act under these conditions.

Q: Putting it another way, when did you first come to the conclusion as to what your opinion was in this matter?

A: This is a difficult thing to say. I tend to reserve coming to a conclusion until I have all of the information that I consider necessary to make the conclusion.

Q: Well, when did you reach a tentative opinion, then, if that helps any?

A: No, I wouldn't say that. Every factor lends some weight to this thing, but an opinion is not, necessarily, a conclusion. You form your . . you schedule your work and your procedure based upon what you learn from one step to the next, and each step determines what you next think. So you are forming tentative opinions and possibilities as you go along.

As with most of the other witnesses, the topic of preventative maintenance was eventually considered.

Q. (by Mr. O'Brien): Do you know anything about preventative maintenance, Mr. Thomas?

A: Yes.

Q: What do you understand by that?

A: This is a procedure by which you attempt to prevent down time or malfunctions of equipment that could lead to disruption of equipment or accidents, whatever the case may be. This is done by a systematic program of providing for the needs of the equipment, replacing of certain components on schedule, based upon their anticipated life and the economies involved in the operation of the plant. I think you could write a book on it, but that is it.

Q: Now, in your opinion, would any preventative maintenance be required with reference to this type of Precision valve that you tested?

A: Yes, sir, in my opinion, it would.

Q: What type of preventative maintenance?

A: I would say that, first of all, would be seeing to it that the lubrication system to the valve was maintained in proper operation. I would also say that the valve should be disassembled to the extent necessary to inspect the basic spools in the pilot chamber on a regularly scheduled basis. I would also say that with this valve as it is, that the spring should be replaced on a regularly scheduled basis.

Q: Now, how frequently would you feel that this should be done, this disassembly of the Precision valve and the component parts?

A: This would depend upon the usage involved, of course, the number of cycles in a period of time, but I would suggest something in the neighborhood of once every six months . . perhaps in the neighborhood of one million cycles.

Q: In your opinion did you ever feel that the manufacturer of the press should have issued complete instructions with respect to the preventative maintenance as to this valve attached to the press?

A: I believe that the National people should put out a recommended preventative maintenance schedule which should involve a statement to this effect, that this spring be replaced in the pilot of the valve if such a valve were used on a press; and this, I think, should be furnished to the purchasers of the press, and they would be the ones who would have to do the preventative maintenance.

Q. (by Mr. Simpson): You indicated that you thought it was the manufacturer, which, in this case, was National, had an obligation upon them to warn their users that they should replace these springs every one million cycles or six months or something like that?

A: I feel that this would be part of the preventative maintenance instructions that would go out with the press that was using a valve of this nature, yes, sir.

Q: And, if the particular manufacturer . . . or the particular user didn't have a preventative maintenance program, it wouldn't make any difference, would it, whether you instructed him or not?

A: I will agree, this is true.

Q: Secondly, in this particular case involving Earl Williams, with the knowledge that we get from the deposition of Mr. Meister, that he was familiar with this particular type of breaking of the springs long before Earl Williams ever got involved with this machine, it really made no difference whether National sent a Bible of instructions or sent nothing, did it?

Mr. O'Brien: I think a Bible of instructions would go to the front office, would it not?

Mr. Simpson: I hope not. I hope somebody out in the back would look at it.

The Witness: Was I asked a question?

(The Witness): It is a little difficult for me to conceive of a company that doesn't have some type of maintenance program.

Mr. Schultz: You could catch your plane if you answer the question.

Mr. O'Brien: I am going to have a continuing objection to this line of questioning.

Mr. Simpson: Go ahead, you can have a continuing objection; it is immaterial.

A: It they don't do anything about it, it becomes immaterial insofar as changing the spring is concerned. It is, also, I think, reasonable to anticipate that it wouldn't be wise to have a press that would be subject to this type of failure anyway.

Q. (by Mr. Simpson): Have you ever seen a machine that never never wore out, sir, if parts weren't replaced?

A: No, sir. Parts wear out.

Q: Even you will accept that, won't you, sir?

A: Yes, sir.

Q. (by Mr. Schultz): Isn't it true that the manufacturer of the valve has no control over the atmosphere in which that valve is going to be used?

A: This is true.

Q: He has no control over the type of lubrication that is going to be used, isn't that true?

A: He should require and provide instructions as to the adequate lubrication . . .

Q: And if the customer doesn't follow his directions, it doesn't make any difference how much he warns, does it?

A: That is true.

As the deposition drew to a close, Mr. Garibaldi asked Mr. Thomas for a final, concise opinion as to what caused the alleged repeat stroke.

A: The end of the spring broke off. The fragment, the small fragment, it was discovered as I understand, in the pilot area, had interacted with the ball and the spring causing a jam of the spring, effectively. You could compare it to a lengthening of the spring, whereby when you tried to push the ball back to unseat from the plate side, the force of the spring was maintained on the ball; this being true, even though the solenoid would have been retracted from completion of the electrical system action.

NEGLIGENCE (D)

Following is a summary of Plaintiff's claims against the three "principal" Defendants (as extracted from Plaintiff's Trial Brief):

(1) A. T. & D.

(a) A. T. & D. sold and supplied a press to subsidiary Associated Products which it knew or should have known was equipped with an air control valve which had caused repeats on its own equipment in previous years.

(b) A. T. & D. systematically set up safer dual valves on its own presses in Cincinnati but never enforced or recommended such a dual valve program for Associated Products (despite its knowledge that Associated was using the inherently dangerous Precision Valve).

(2) Precision Valve Corp.

(a) The design of the valve pilot section was "wrong" and inappropriate." The spring used was unground, "in violation of sound basic engineering knowledge existing in 1948-49," and this condition produced "distorted and uneven stressing" of the spring, "causing it to break in 1964."

(b) The valve was designed so as to fail in an unsafe, i.e., engaged, position which "is contrary to basic air valve and control systems principle."

(c) Precision Valve Corp. failed to discover the defects cited in (a) and (b) despite the pilot spring failures experienced by at least one customer (e.g., A. T. & D.) and despite having rebuilt hundreds of valves over a ten year period.

(d) The valve was never life-tested nor customers advised of a "useful life."

(e) No useful maintenance, repair, or replacement instructions were established.

(3) National Power Press Co.

(a) National "totally failed" to adopt a safe air control system for its press. "Contrary to every precept of sound engineering and design practice," the safety and integrity of the entire system was made to depend upon the durability and integrity of an unground spring costing less than 1/10 of a cent. This, we submit, was a poor plan, a poor design, and poor judgment."

(b) National negligently tested the valve "in the extreme." Mr. Lucas' alleged test was "wholly inadequate" because:

(i) the life of an average National press is at least 10,000,000 cycles while the test lasted for only about 1,000,000 cycles.

(ii) no records of the test were kept.

(iii) there was no determination of whether the valve was leaking air . . "a central factor in the Williams accident."

(iv) Precision Valve Corp. was "probably aware" that National intended to life-test only one valve and supplied such a valve specifically for test purposes.

(v) the test was performed on a valve with a ground pilot spring while production valves had unground springs.

(c) National failed to establish a "useful life" for the valve and to advise customers accordingly.

(d) National's press maintenance manual failed to mention anything about air control valve maintenance or replacement although such instructions were supplied for the clutch-brake and other components.

(e) National failed to investigate their customer's experiences with the Precision Valve even though numerous valves were returned to them for servicing (some within a year or two of purchase).

(f) National failed to adopt an anti-repeat clutch mechanism on its press.

Some of the legal considerations extracted and condensed from Plaintiff's Argument follow:

(1) The law of Alabama applies since Plaintiff's injuries and damages arose out of an accident in Alabama.

(2) Defendants owed Plaintiff a duty not to act so as to expose him to a substantial risk of harm resulting from their failure to use due care.

This duty, as stated in State Stove Manufacturing v. Hodges, 189 So. 113 (Miss. 1966), p. 116, is as follows:

"The manufacturer, by placing a chattel or product upon the market, assumes a responsibility to the customer resting not upon contract but upon the relationship arising from the purchase, together with the foreseeability of harm if proper care is not used . . . The rule we adopt extends to any product, if in fact negligently made, which may reasonably be expected to be capable of inflicting injury."

In order to prove his case, Plaintiff need not show that the press in question was imminently or inherently dangerous but only that Defendants should have anticipated that if they were negligent, substantial harm could result to anyone who might be expected to be in the vicinity of the probable use of the press.

(3) The manufacturer of a chattel has a duty to use due care in the design, selection of materials, fabrication, inspection, testing, and packing of his product.

This duty is affirmed in the Restatement of Torts, Second, § 395, comment (f):

"f. Particulars which require care. A manufacturer is required to exercise reasonable care in manufacturing any article which, if carelessly manufactured, is likely to cause harm to those who use it in the manner for which it is manufactured. The particulars in which reasonable care is usually necessary for protection of those whose safety depends upon the character of chattels are: (1) the adoption of a formula or plan which, if properly followed, will produce an article safe for the use for which it is sold, (2) the selection of material and parts to be incorporated in the finished article, (3) the fabrication of the article by every member of the operative staff no matter how high or low his position, (4) the making of such inspections and tests during the course of manufacture and after the article is completed as the manufacturer should recognize as reasonably necessary to secure the production of a safe article, and (5) the packing of the article so as to be safe for those who must be expected to unpack it."

(4) A supplier of a chattel has a duty to warn those who must use his product. The Restatement of Torts, Second, § 388, establishes the liability of suppliers as follows:

"One who supplies directly or through a third person a chattel for another to use, is subject to liability to those whom the supplier should expect to use the chattel with the consent of the other or to be in the vicinity of its probable use, for bodily harm caused by the use of the chattel in the manner for which and by a person for whose use it is supplied, if the supplier:

(a) knows, or from facts known to him should realize, that the chattel is or is likely to be dangerous for the use for which it is supplied;

(b) and has no reason to believe that those for whose use the chattel is supplied will realize its dangerous condition; and fails to inform them of its dangerous condition or of the facts which make it likely to be so."

Furthermore, a California court has held that: "A manufacturer, as well as a dealer, must give adequate warning to the ultimate users of the product of any dangerous propensity which it knows or should have known would result in the type of accident that occurred."

(5) The special liability of a seller of a product for physical harm to a user or consumer is contained in Restatement of Torts, Second, § 402(a), p. 374, which states:

"(1) One who sells any product in a defective condition unreasonably dangerous to the user or consumer or to his property is subject to liability for physical harm thereby caused to the ultimate user or consumer, or to his property, if

(a) the seller is engaged in the business of selling such a product, and
(b) it is expected to and does reach the user or consumer without substantial change in which it is sold.

(2) The rule in subsection (1) applies although

(a) the seller has exercised all possible care in the preparation and sale of his product, and
(b) the user or consumer has not bought the product from or entered into any contractual relation with the seller."

In order to prove seller's or manufacturer's liability, Plaintiff can find guidance in this statement from State Stove, supra, p. 7016:

"If the article left the Defendant's control in a dangerously unsafe condition, or was not reasonably safe, or was unsafe for its intended use, the Defendant is liable whether or not he was at fault in creating that condition, or in failing to discover and eliminate it . . . Plaintiff will not need to prove either that Defendants negligently created the unsafe condition of the product or that he was aware of it."

(6) Plaintiff can only be held to assume the risk of a danger known, appreciated, and deliberately exposed to and cannot be held to assume the risk of a danger partly created by his employer's negligence, if any. In any event, if Plaintiff's employer was negligent, his

negligence combining with Plaintiff's possible negligence eliminates the defense of assumption of risk, as confirmed in Miss. Stat. Ann. § 1456, p. 310:

"In all actions for personal injury to an employee, and in all actions where such injury results in death, such employee shall not be held to have assumed the risks of his employment in any case where such injury or death results in whole or in part from the negligence of the master; except as to conductors, or locomotive engineers, in charge of dangerous or unsafe cars or engines voluntarily operated by them."

The Earl Williams case never reached a trial. On the morning of the day that the trial was to begin, an out-of-court settlement was reached in which the Defendants agreed to pay the following damages:

A. T. & D.	$112,500
National	25,000
Precision Valve	25,000
United Spring	10,000
Western Aerospace	7,500
TOTAL	$180,000

INSTRUCTOR'S NOTES

Part A

(1) Have students assume Thomas' role as an expert witness. (a) after reviewing material of Part A, what would be next step(s) in the investigation? (b) can students come up with a "failure hypothesis" on the basis of information presented so far?

(2) What are other possible ways in which valve (or press in general) might cause such an accident? (e.g., electrical failures)

(3) Discussion of maintenance could begin here. (Part B shows opinions of expert witnesses on maintenance)

Part B

(1) Have students do spring calculations. (a) check against Mr. Abram's figures (consider only compression loading here, will add radial load effect in Part C), (b) estimate fatigue life, (c) estimate number of cycles for life of press and compare to (b)

(2) Discuss Mr. Lucas' alleged life test. Have students devise their own test scheme.

(3) Discuss the various viewpoints of maintenance.

Part C

(1) Have students repeat spring calculations, this time taking into account the radial loading (a) check against Mr. Thomas' figures, (b) estimate fatigue life.

(2) Discuss valve design (pilot section in particular) "flaws" as Mr. Thomas did. Can students devise a "fail-safe" design?

(3) Discuss Mr. Thomas' test to determine cause of failure. What do students believe was the cause?

(4) How was press able to be "inched" if failure occurred as Mr. Thomas suggested?

(5) Discuss preventive maintenance again in view of Mr. Thomas' comments.

Part D

(1) Discuss Plaintiff's claims. Do you think that they're justified?

(2) Do you think that the damages properly represent what you feel were the responsibilities of each defendant?

(3) Do you think Western Aerospace should be held responsible?